Parental Rice line Breeding and New Variety Breeding in Korea

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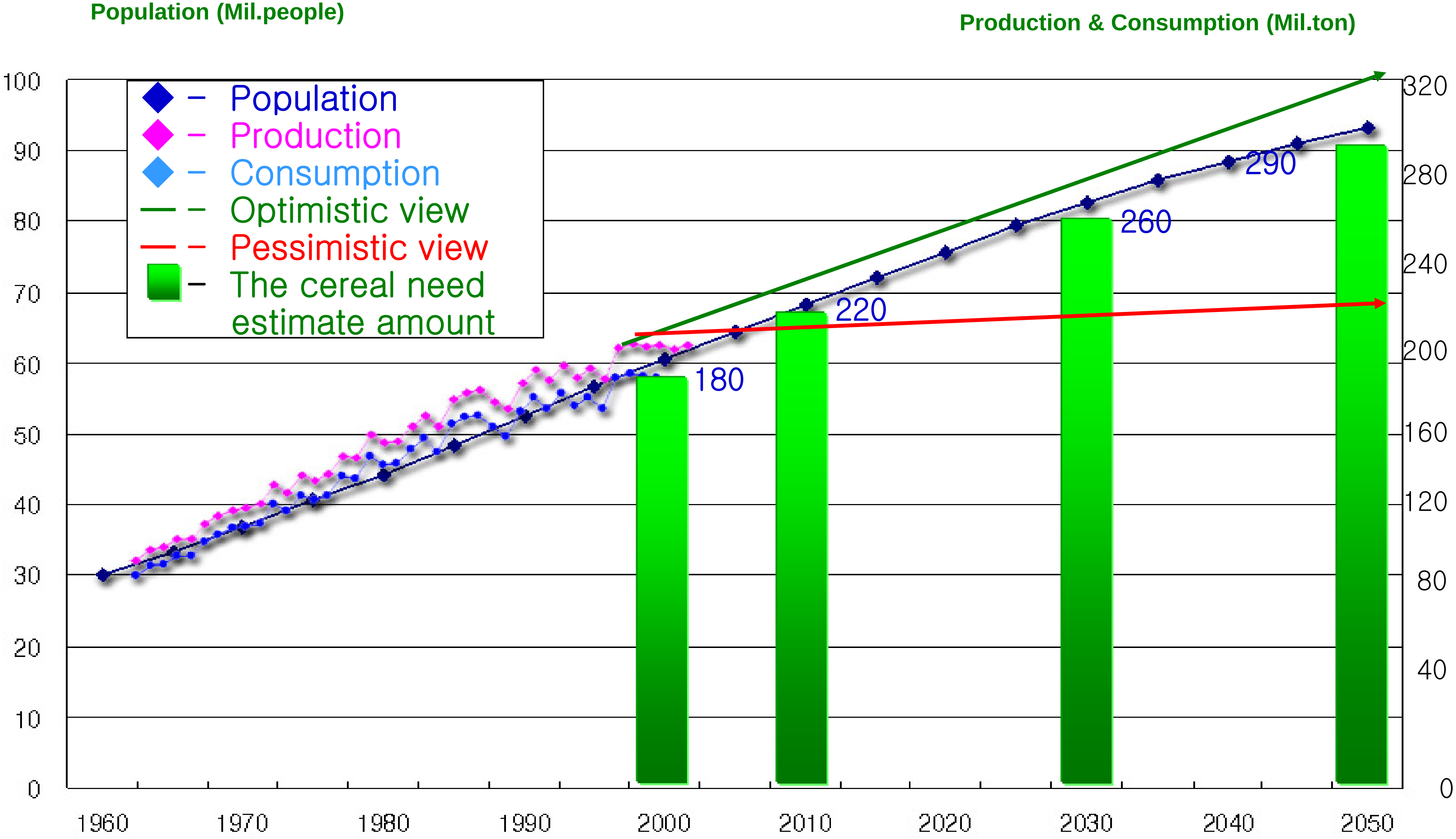
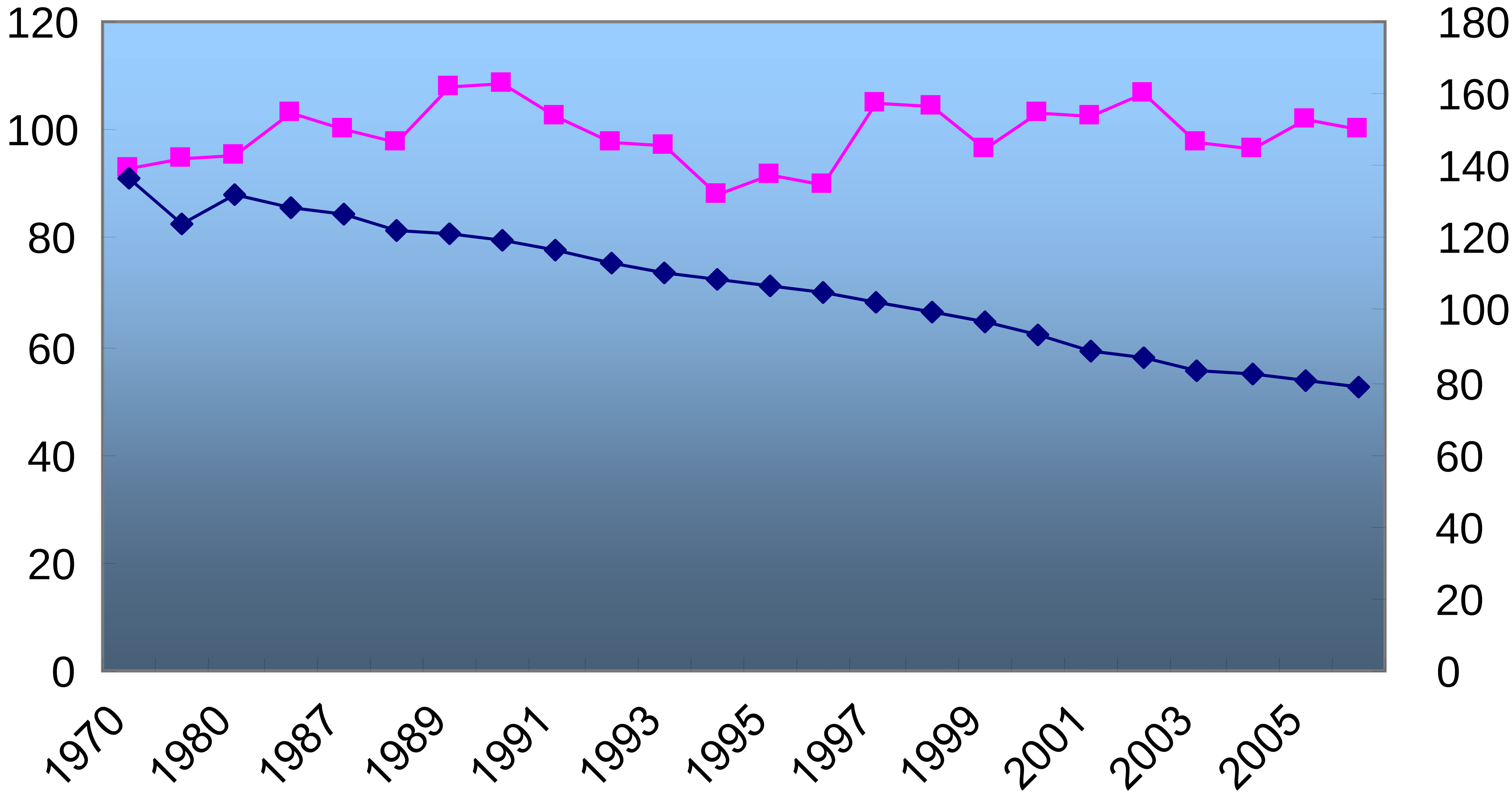
The View of World Cereal Supply and Demand



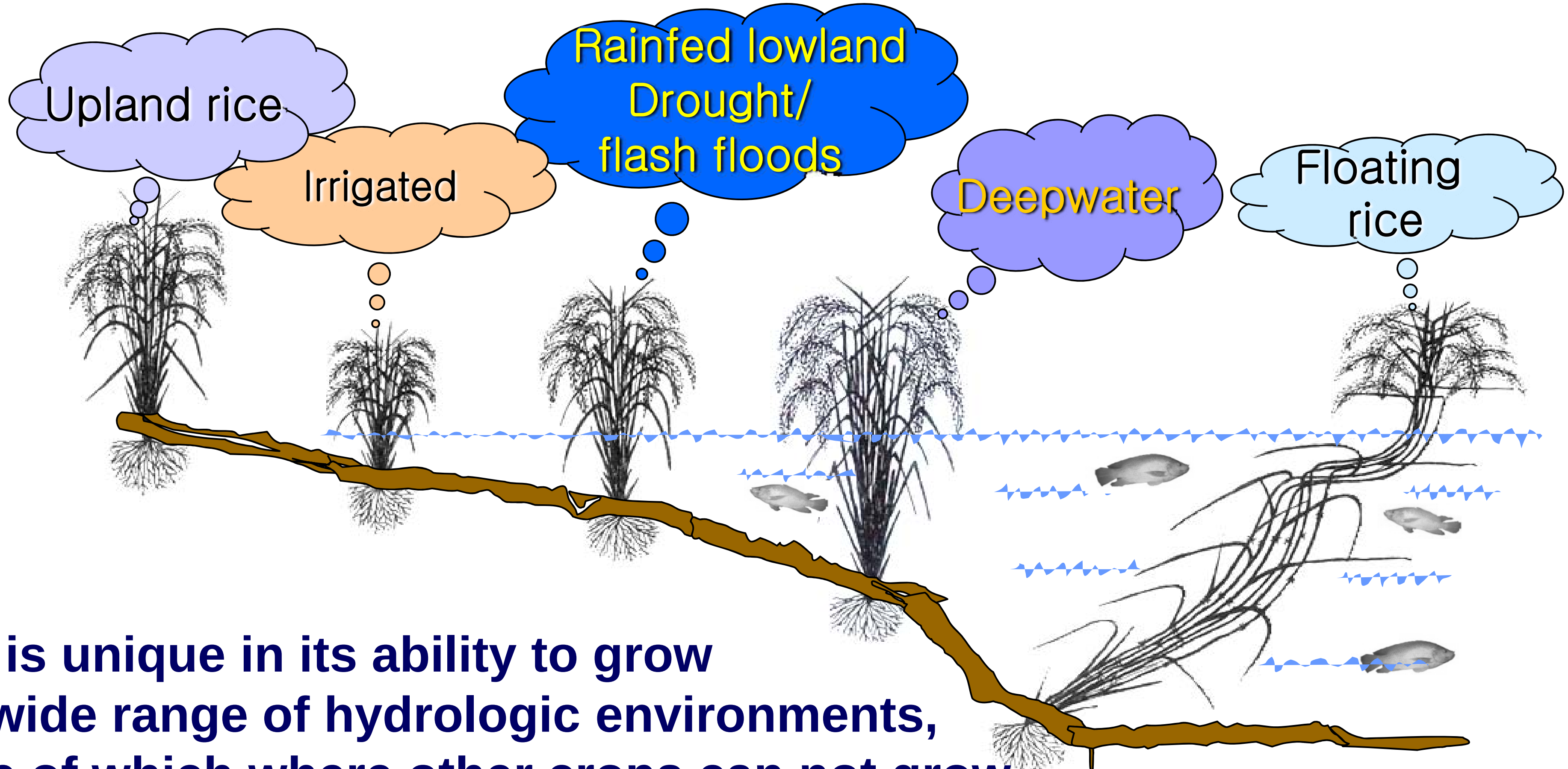
Rice Consumption per Capita and Self-Sufficiency in Korea



Changes in Rice Acreage and National Average Milled Rice Yield During the Last Five Decades in Korea

Year	Area (1,000 ha)	Yield (ton/ha)	Product. (1000 ton)	Consump. (kg/pers/yr)	Self-sufficiency(%)
1965	1,228	2.85	3,501	121	101
1970	1,203	3.30	3,939	136	93
1975	1,218	3.86	4,669	123	95
1980	1,223	2.89	3,550	132	95
1985	1,237	4.56	5,625	128	103
1990	1,244	4.51	5,606	120	108
1995	1,056	4.45	4,695	107	91
2000	1,072	4.97	5,291	93	103
2005	980	4.90	4,768	81	102
2008	927	5.20	4,843	76	99

Rice Ecosystems



Rice is unique in its ability to grow in a wide range of hydrologic environments, some of which where other crops can not grow

Water Condition

- **Irrigated**
  - Leveled
  - Bunded fields with water control
  - Transplanted or direct seeded in puddled soil
  - Shallow flooded in anaerobic soil during crop growth
- **Rainfed**
  - Level to slightly sloping
  - Bunded fields
  - Non-continuous flooding
  - Water level < 50 cm
  - Transplanted or direct seeded on puddled or plowed dry soil
  - Aerobic or anaerobic soil

Water Condition

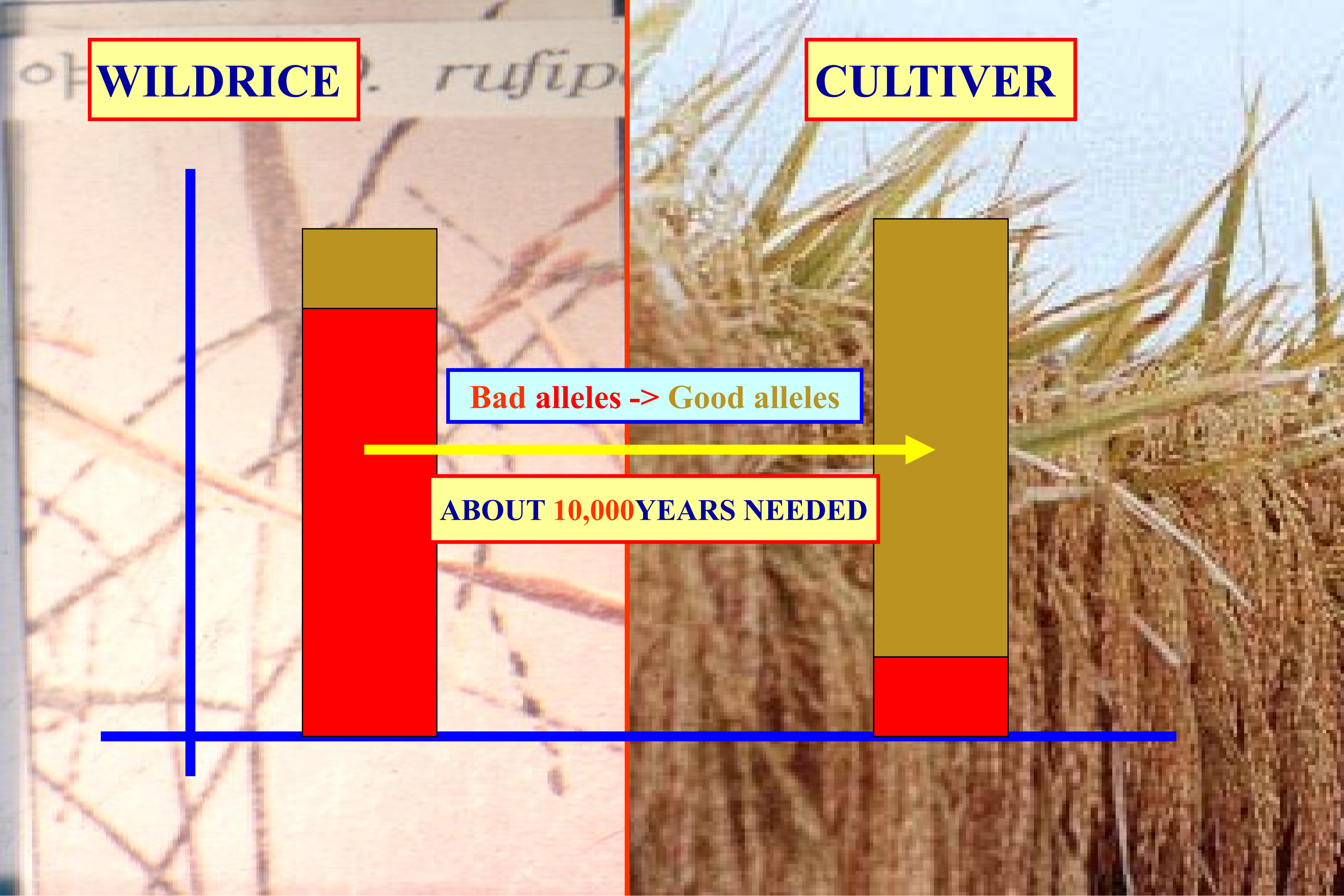
Upland

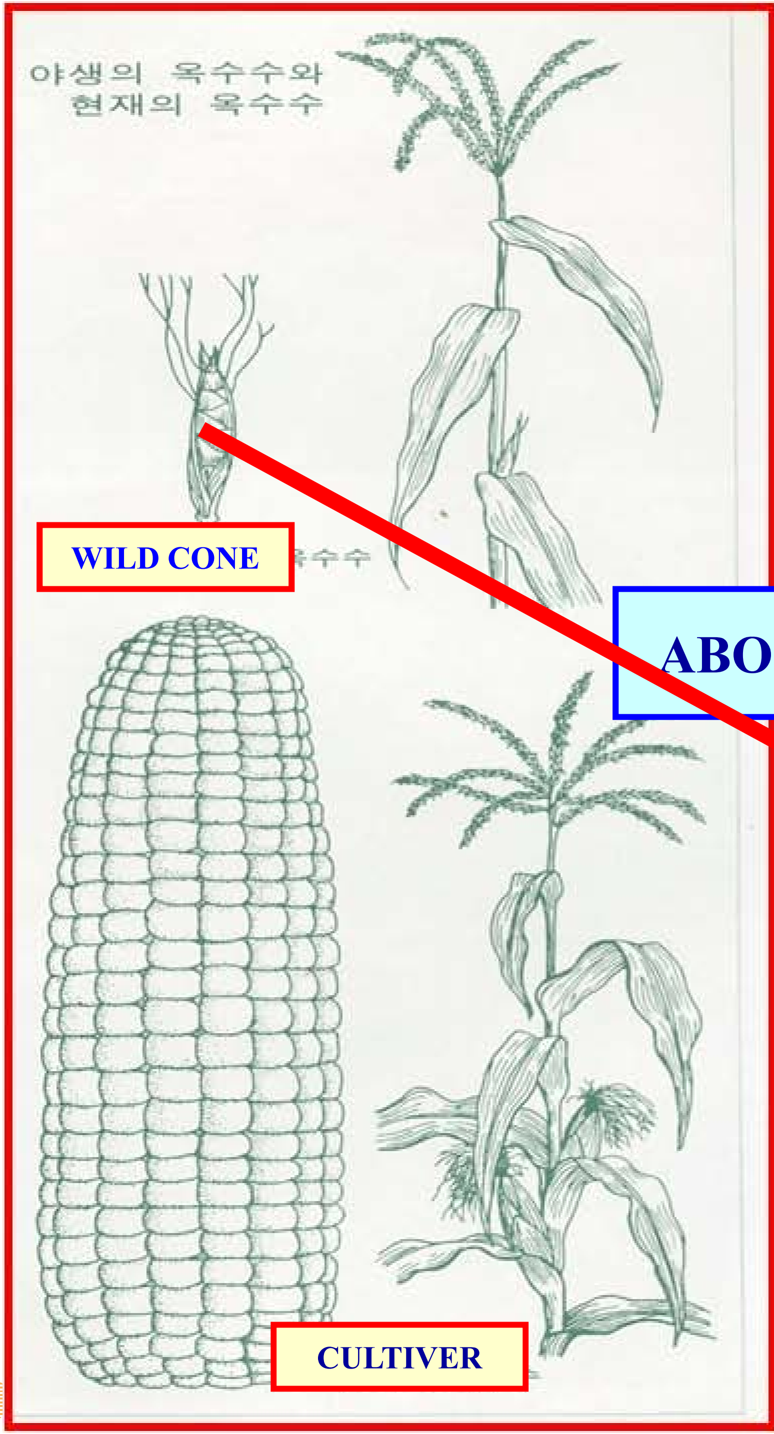
- Level to steeply sloping fields
- Rarely flooded
- Aerobic soil
- Direct seeded- plowed dry soil/dibbled in wet nonpuddled soil

Flood Prone

- Level to slightly sloping
- More than 10 days of medium to deep flooding (50 to 300 Cm)
- Transplanted or direct seeded
- Aerobic or anaerobic soil
- Soil salinity or toxicity in tidal areas

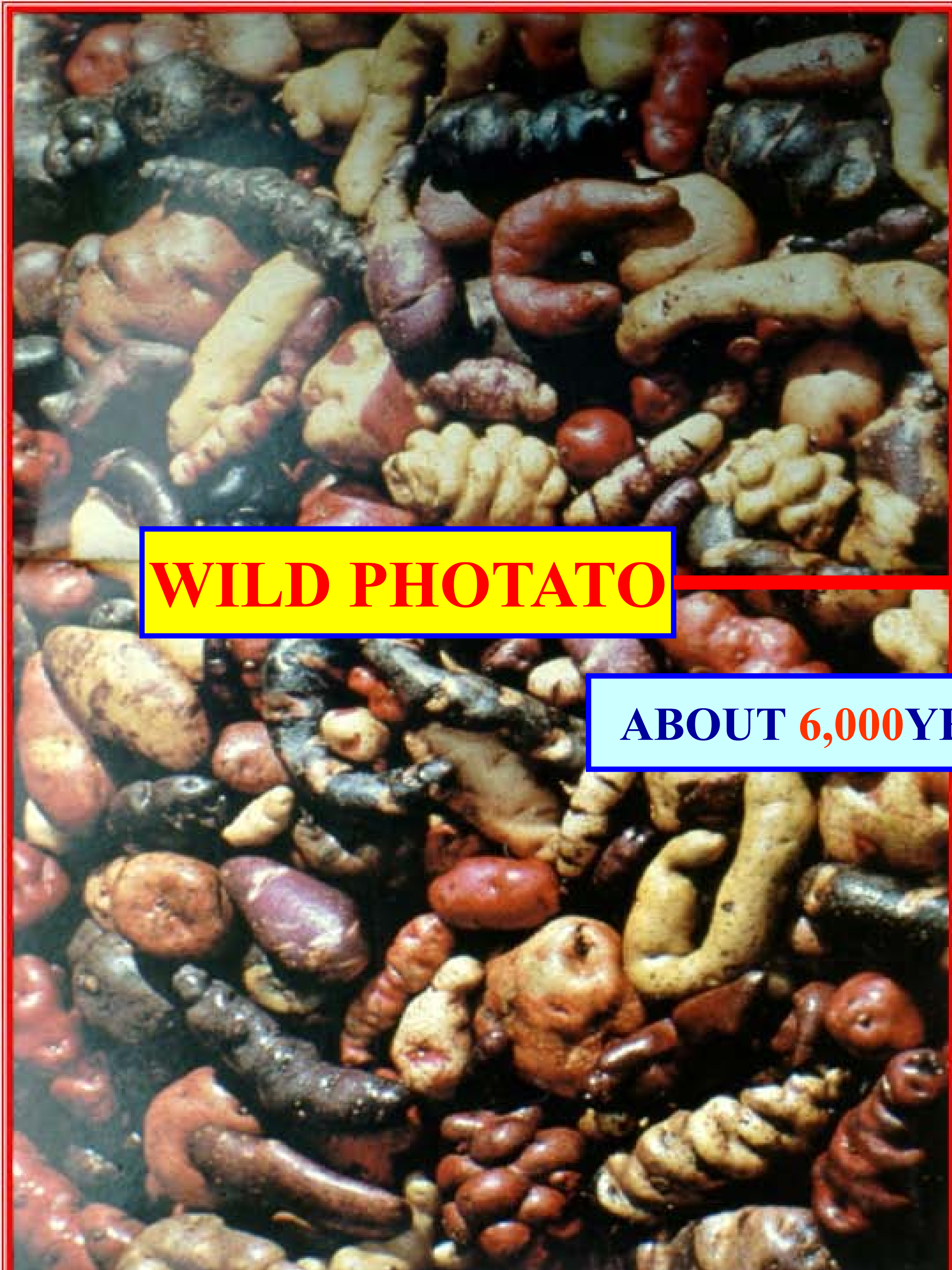
Rice Breeding in Korea


WILDRICE
CULTIVER
Bad alleles -> Good alleles
ABOUT 10,000YEARS NEEDED



ABOUT 6,000YEARS NEEDED

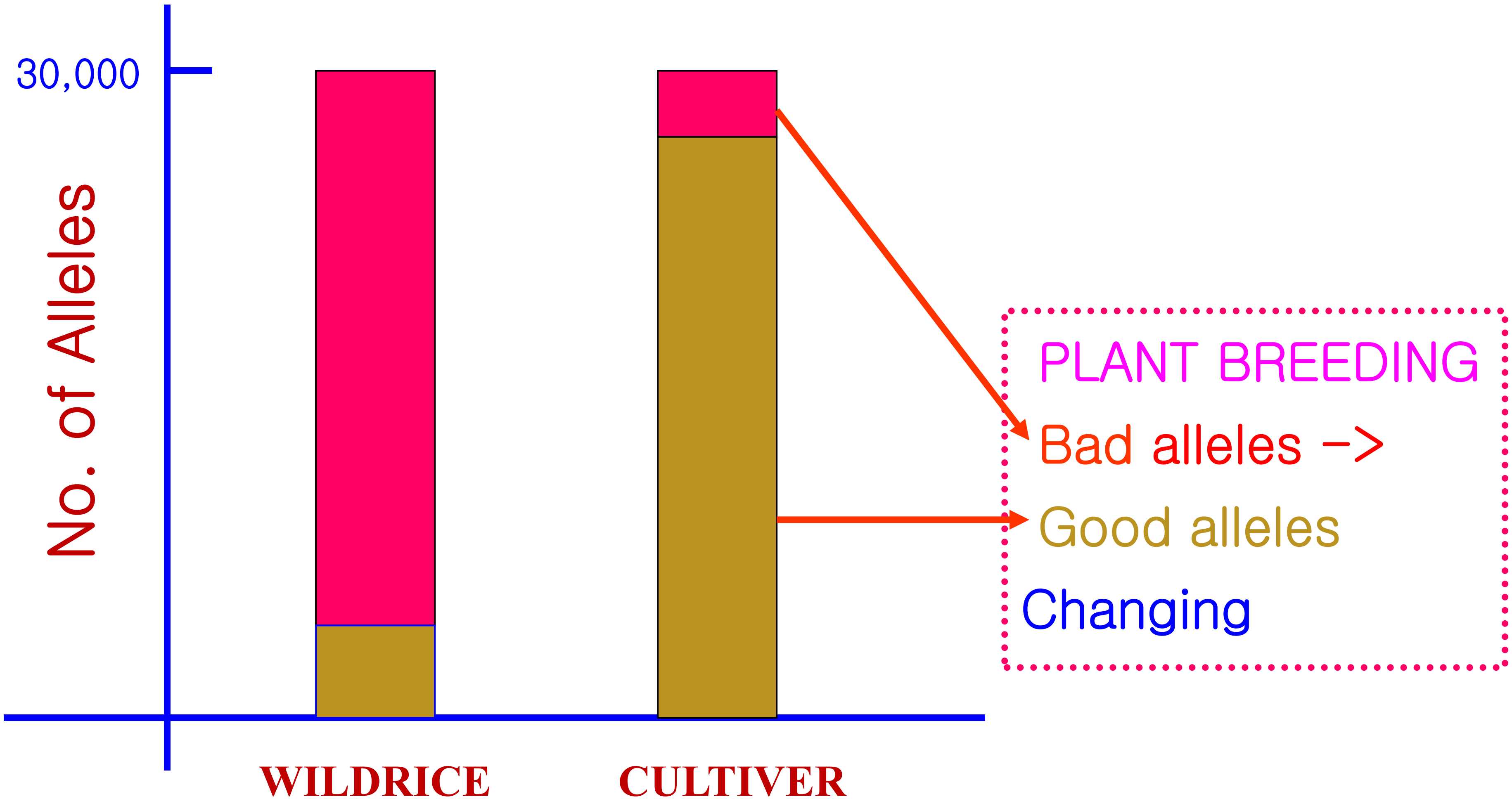
그림 5-19
A. 테오신트.
B. 약 7cm 길이의 테오신트 열매 (왼쪽)와, 껍질을 깐 후 드러난 낟알 줄. 익으면 낟개로 떨어진다.



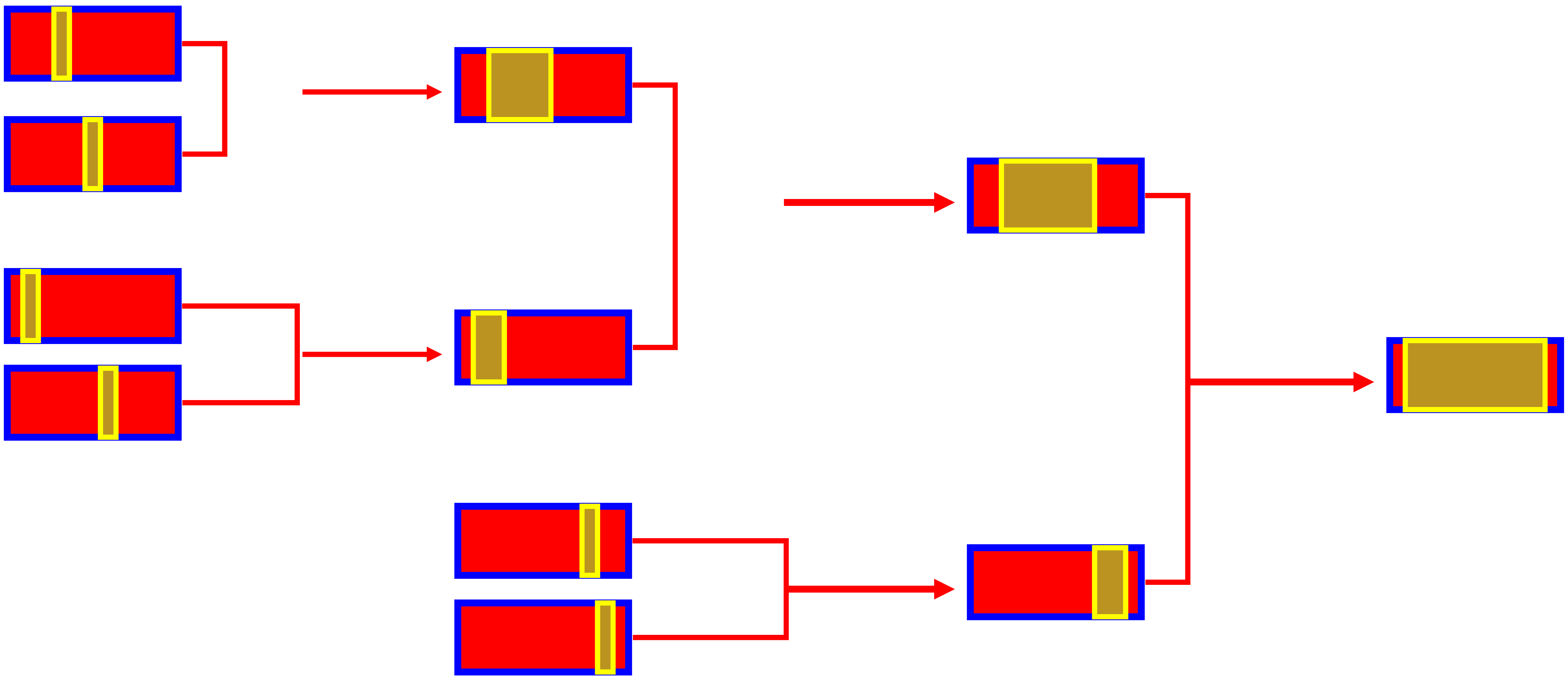
WILD PHOTATO → **CULTIVAR**

ABOUT 6,000YEARS NEEDED

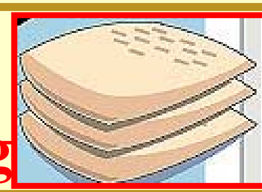
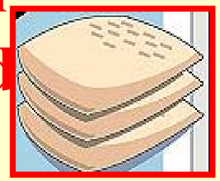
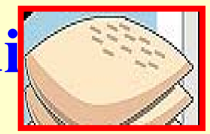
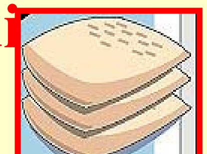
The breeding is fold good Alleles !



Folding of Effective Good Alleles



Selection

Plant breeding			
		Yielding	
		High Yielding 	**Low Yielding** 
Resis- tance	**R** 	**High Yield R**  	**Low Yieldi R**  
	S 	**High Yieldi S**  	**Low Yieldi S**  

Plant Breeding Effect

- Evolution Directed by the Will of Man
- Genetic Adjustment to the Service of Man
- Adaptational Change by Gene-Substitution under Artificial selection
- Integrated Science with Related Sciences
- Grounded on Genetics
- Based on Agriculture and Society to be served

Progressive Breeding Methods for Increasing Yield Potential

- **Past and present**

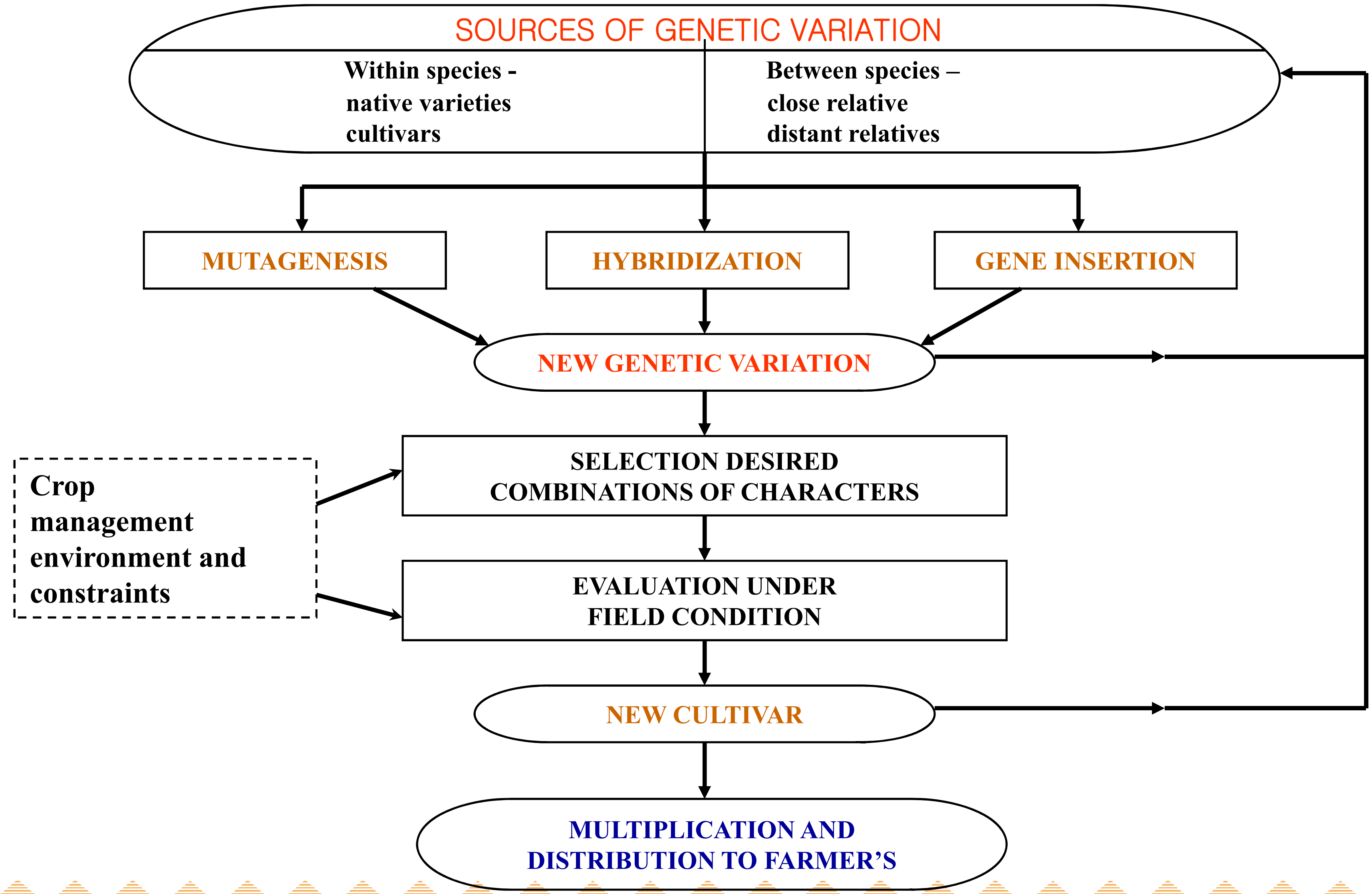
Parents	**Inbred variety**		**Same group Different varieties**	
	$\otimes$ ↓		V_1 x V_2 ↓	
Cultivar	**Pure line**		**Intra-varietal hybrids**	
Breeding method	**Selfing (pure line)**	→	**Within-group hybridization**	→
Phase	**Past**		**Present**	

Progressive Breeding Methods for Increasing Yield Potential

- **Future**

Same species different groups		**Different subspecies species, genus**
G_1 x G_2 ↓ **Inter-varietal hybrids**		S_1 x S_2 ↓ **Distant hybrids**
Between-group hybridization	→	**Wide hybridization**
Present-future		**Future**

Plant Improvement by Breeding



Achievement of Plant Breeding in World

- **Development of Hybrid Variety**
- **Successful Use of Semi-dwarf Gene**
- **Genetic Resistance to Diseases and Insects**
- **Application of Cytogenetics**
- **Exploitation of Genetic Resources**

Limitation to Breeding Strategies

- **Genetic Linkage**
  - **Limited introgression of genes from wild species**
  - **Difficult to detach undesirable genes closely linked**
- **Polygenes from Wild Populations**
  - **Difficult to utilize unadapted wild populations or different species**
- **Complex Traits**
  - **Difficult to access and to identify attendant components**
- **Difficulties Identifying Useful Mutants**
  - **Very low frequency, and difficulty in identifying**
  - **Long-Time Scale of Slow Procedures**

Commonly used Conventional Breeding Methods

Mass Selection

Pure Line Selection

Pedigree Breeding

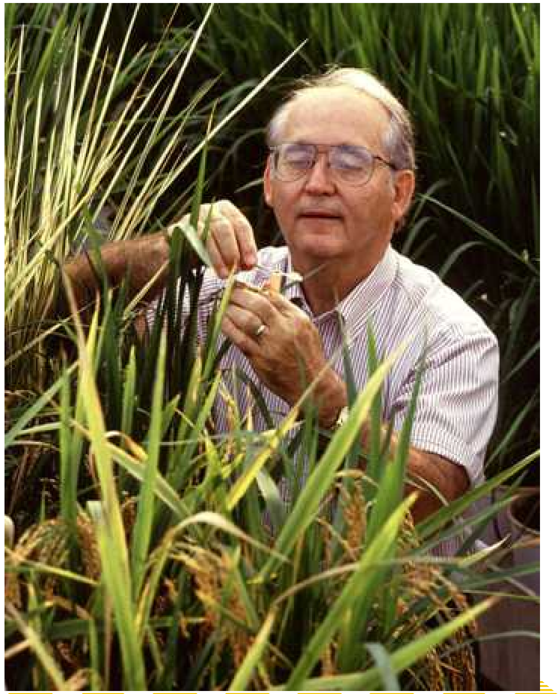
Bulk Breeding Method

Single-seed Descent

Recurrent Selection

Back Cross Breeding

Additional method



Mass Selection

- Selection of individuals
- Sampling seed of selected individuals to plant next generation
- Oldest method of crop improvement with old local or purify existing variety
- Improvement of heterogeneous native populations or landraces
- Select and bulk few hundred to few thousand superior plants on the basis of phenotype

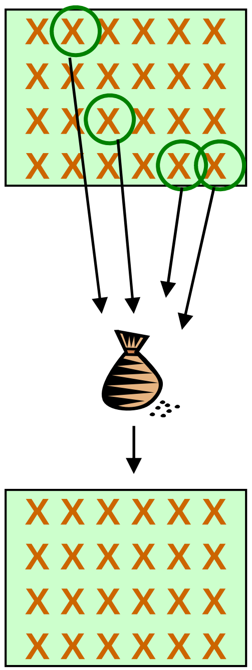
- Only those varieties that show genetic variation can be improved through mass selection.

Mass Selection

- Higher percentage of desirable genotypes
- Method can only be used in environments where trait is expressed - may not be suitable for off-season winter nurseries
- Effectiveness is function of heritability
- Manage field to enhance differences

: eg. irrigate excessively to increase disease pressure

Mass Selection



- Grow population
- Allow random mating
- Harvest and bulk seed from desirable plants
- Plant new generation
- Repeat

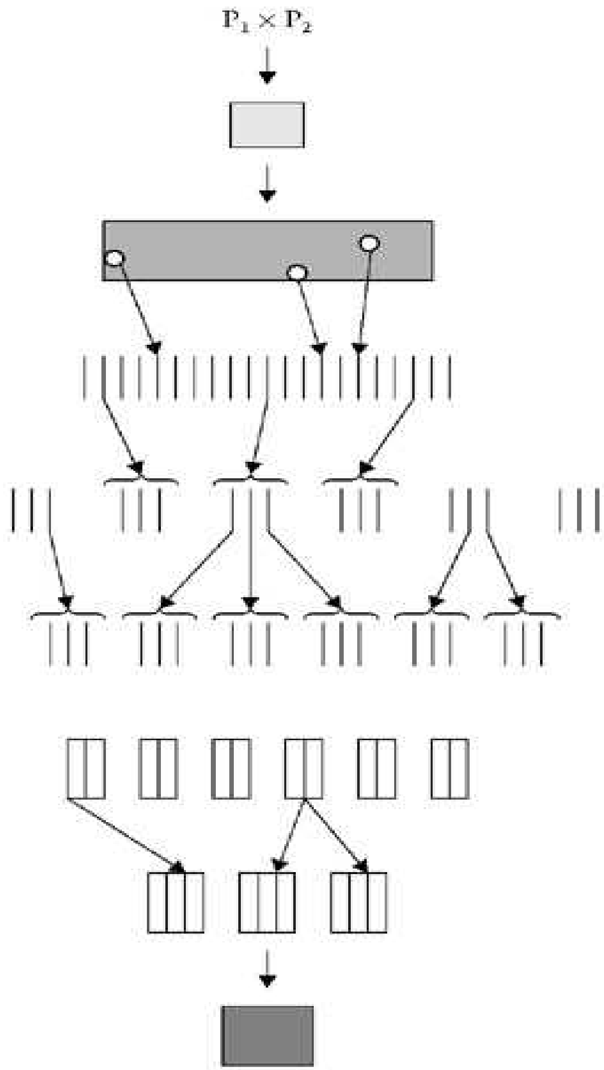
Pureline selection

- **Pureline is the progeny of a single, homozygous, self pollinated plant.**
- **Select a large number of plants whose individual progenies are tested and the best progeny is released as a variety.**
- **It is used to develop a variety from local selections, introductions and old pureline varieties.**
- **Pureline varieties are extremely uniform. Examples: Mtu1, Patni6, T22 (India)**

Pedigree Selection

- **The most popular breeding method in rice.**
- **Individual plants are selected starting with F2 (250-500)**
- **In the subsequent segregating generations their progenies are tested.**
- **Selection is practiced between and within progeny families**
- **Data on reaction to diseases and insects and grain quality etc. are scored starting F4**
- **When progenies become homozygous they are bulk harvested and promoted to yield trials.**

Pedigree Breeding Method



	Generation	Number of plants	Action
Year 1			Select parents and cross
Year 2	F_1	50–100	Bulk seed; space plant for higher yield
Year 3	F_2	2,000–5,000	Space plant for easy visual selection
Year 4	F_3	200	Select and plant in spaced rows
Year 5	F_4	100	Identity superior rows; select 3–5 plants to establish family in progeny rows
Years 6–7	F_5–F_6	25–50	Establish family progeny rows; select individual plants to advance each generation
Year 8	F_7	15	Conduct preliminary yield trials; select individual plants to advance
Years 9–11	F_8–F_{10}	5–10	Conduct advanced yield trials with more replications and over locations and years
		1	Cultivar release

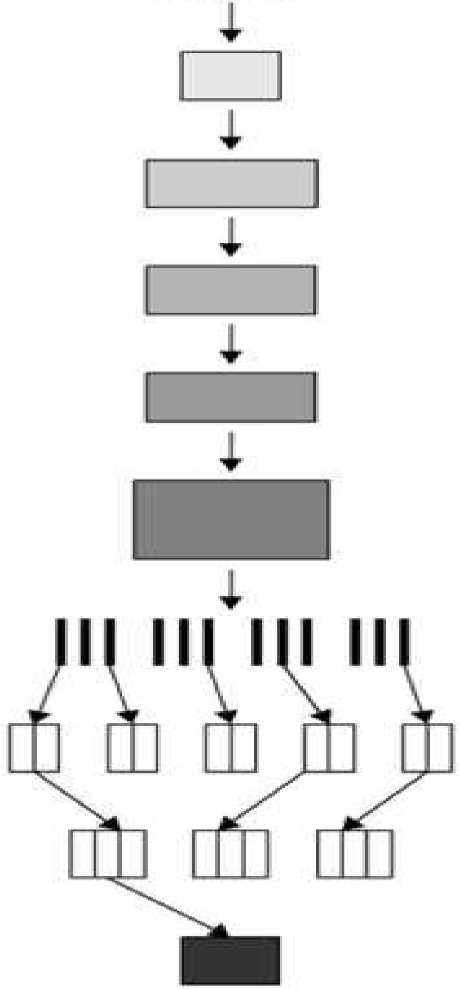
Pedigree Nursery

Pedigree Breeding Record

- **A pedigree record is kept**
- **Naming of pedigree is based on the cross number and serial numbers of selected plants (YR 6900-256-3-1-3)**

  - **Pedigree method is the most extensively used method for handling the segregating generations from crosses**
  - **Majority of RDA bred elite lines and varieties have been developed by the pedigree method**

Bulk Breeding Method

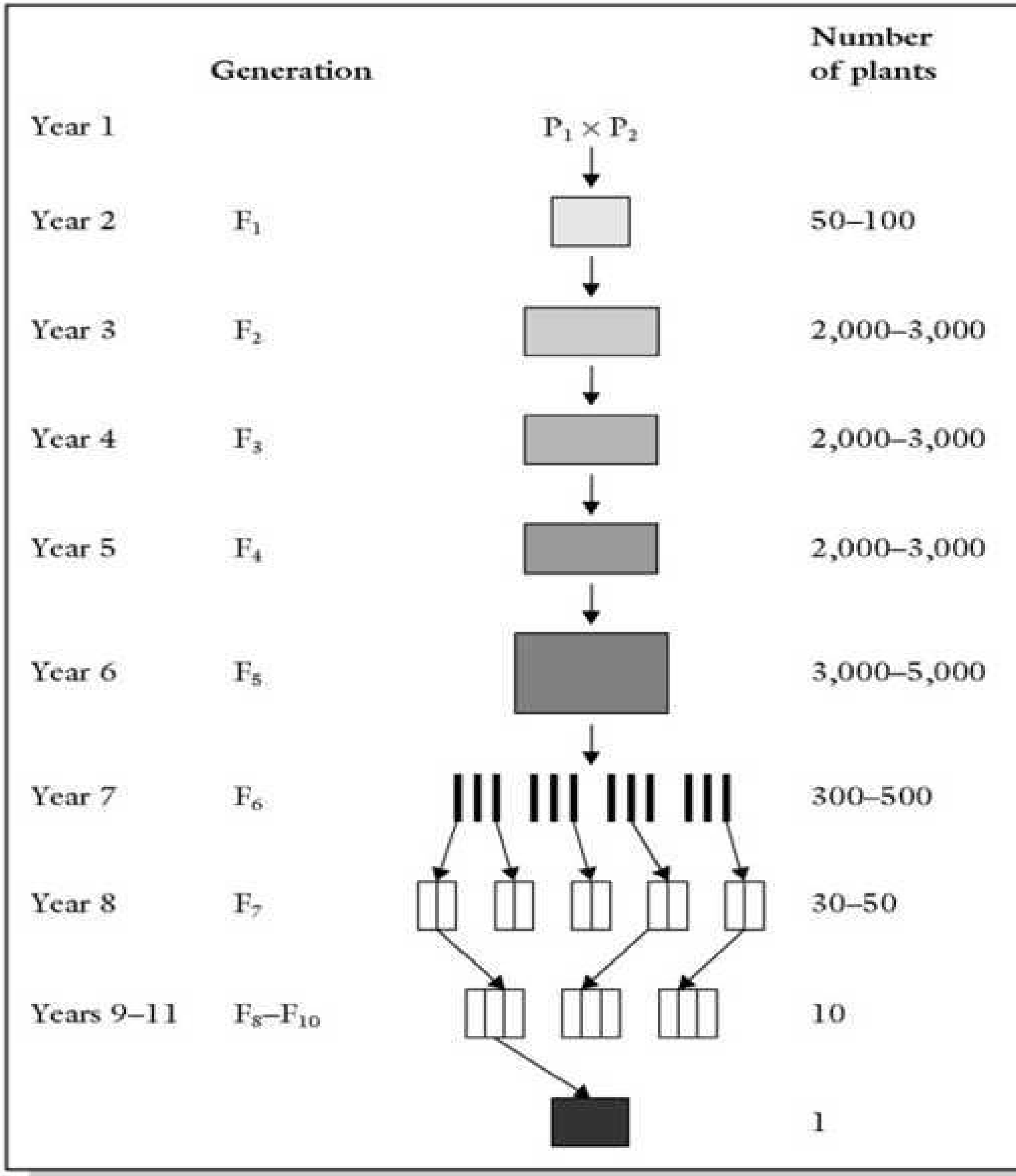


	Generation		Number of plants	Action
Year 1		$P_1 \times P_2$		
Year 2	F_1		50–100	Bulk and space plant F_1
Year 3	F_2		2,000–3,000	Bulk and plant at commercial seeding rate
Year 4	F_3		2,000–3,000	Bulk and plant at commercial seeding rate
Year 5	F_4		2,000–3,000	Bulk and plant at commercial seeding rate
Year 6	F_5		3,000–5,000	Space plant; select superior plants
Year 7	F_6		300–500	Select and establish family rows from plants or heads
Year 8	F_7		30–50	Conduct preliminary yield trials
Years 9–11	F_8–F_{10}		10	Conduct advanced yield trials
			1	Cultivar release

Bulk Breeding Method

- **Procedure for inbreeding a segregating population until the desired level of homozygosity is reached**
- **Easy way to maintain populations**
- **Natural selection permitted to occur in target environment**
- **F2 and the subsequent generations are harvested as bulk with or without selection**
- **At the end of the bulking period (4-5 cycles) individual plants are selected and their progenies are evaluated**
- **It is not a popular method as it does not allow the concurrent screening for a number of diseases and insects as well as other quality and agronomic traits**

Single Seed Descent Method



Action

Grow F1 plants, harvest all F2 seeds per plant

Grow F2 population, <u>harvest one seed per plant</u>
Grow F3 population, <u>harvest one seed per plant</u>
Grow F4 population, <u>harvest one seed per plant</u>

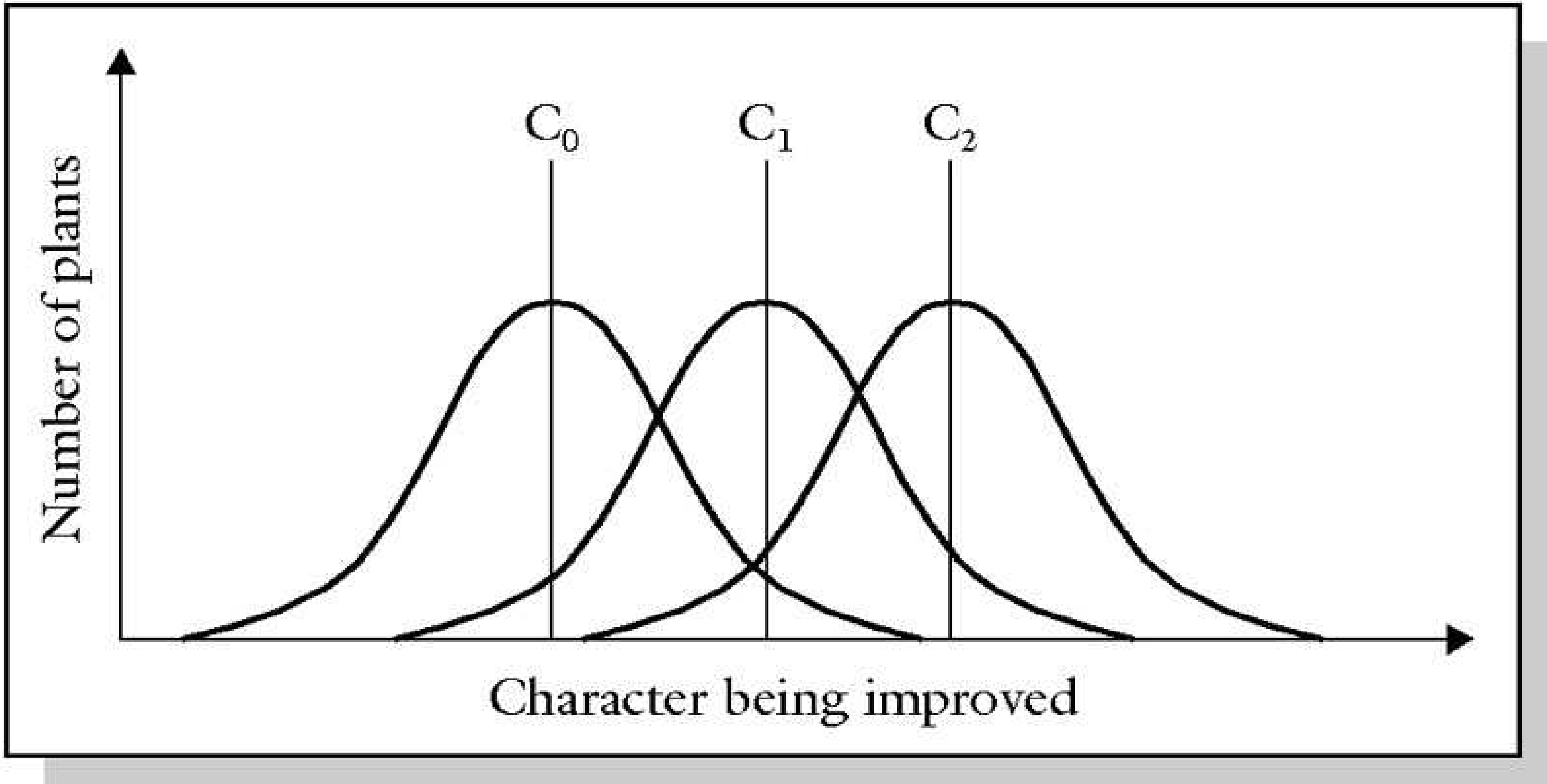
Space-plant to grow F5, <u>select best single plants</u>
Grow F5-derived plant rows In the F6 generation (F5:6)
Yield Test in F7 (F5:7 rows)

Yield Test in F8 (F5:8 rows)
Yield Test in F9 (F5:9 rows)
Large-scale seed increase for variety release

Single Seed Descent Method

- **Easy way to maintain and inbreed (Very little record keeping, No selection)**
- **All genotypes are sampled**
  - **useful for random genetic studies**
  - **Natural selection does not influence population**
- **Well suited to off-season winter nurseries**
- **One seed from each from a large number of F2 plants of a cross and the subsequent generations is used to raise the next generation until F6/F7 generation**
- **It is possible to grow 3-4 generations in a year**
- **SSD is primarily used to develop mapping populations**

Recurrent Selection



Recurrent Selection

- **Families created**
  - **Parents crossed in all possible combinations**

- **Families and plants/families evaluated**

- **New set of superior parents selected**

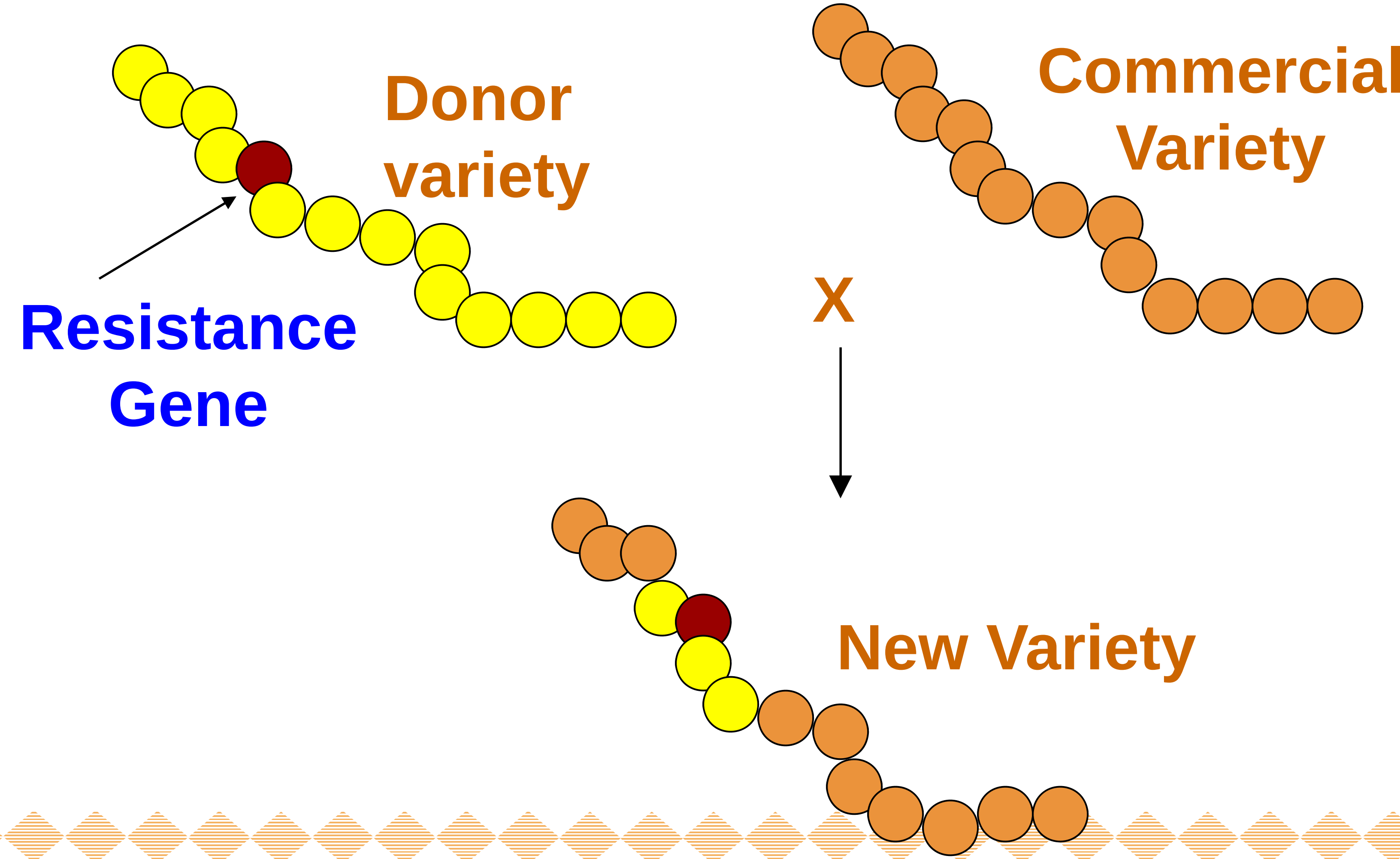
- **Inter-mated in all possible combinations, forming next generation cycle -- <u>improved</u>**

Recurrent Selection / Population Breeding

- **Outstanding plants from F2 and/or other segregating generations are mated among themselves**
- **It provides ample opportunities for recombination and helps in the accumulation of desirable genes for quantitative traits**
- **Male sterility system must be used for attempting crosses**
- **This method is used primarily to improve the parental lines used in hybrid breeding at RDA**

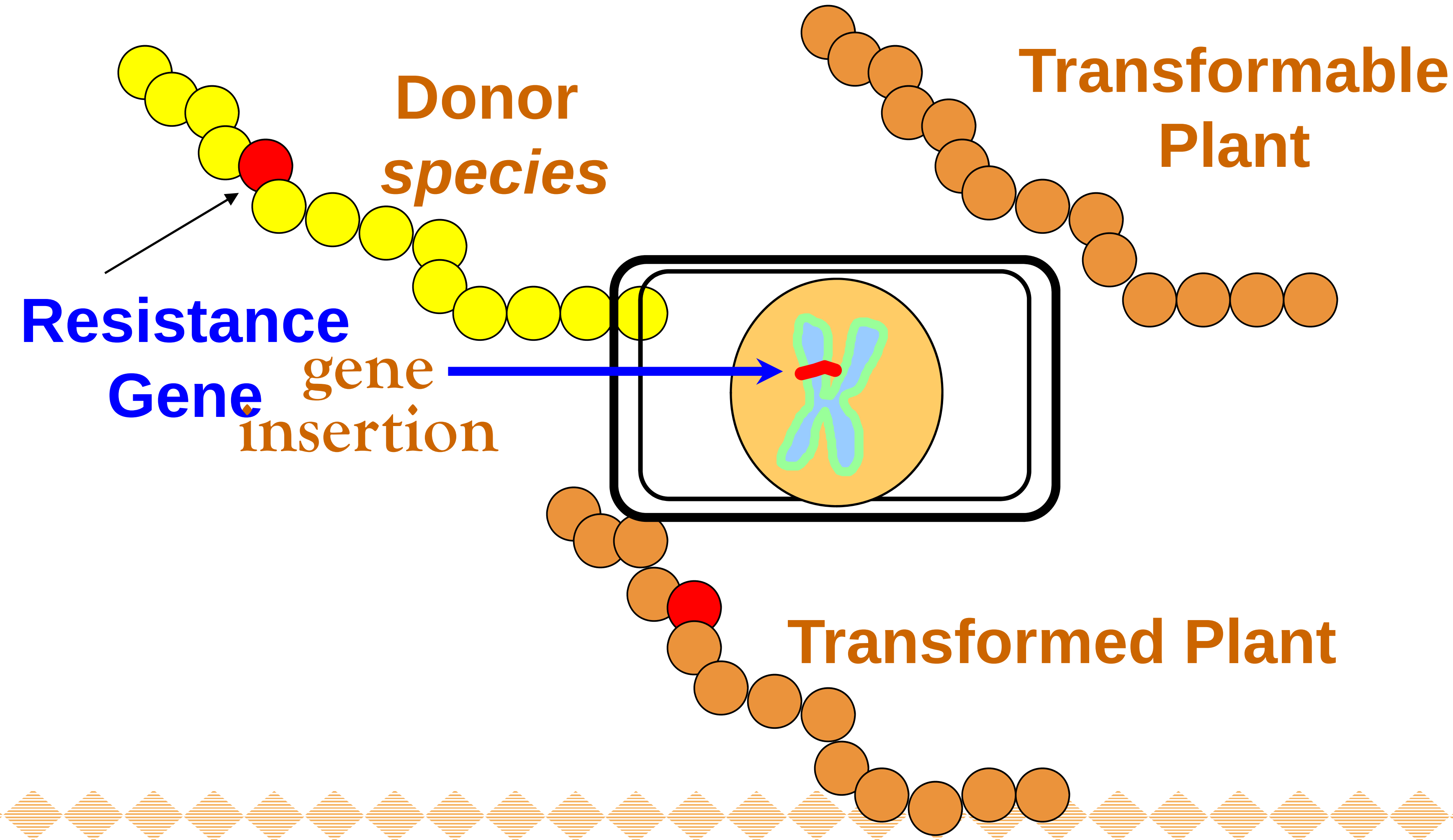
Backcross Breeding

Single Gene Transfer :
Linkage Drag with Traditional Backcross Breeding



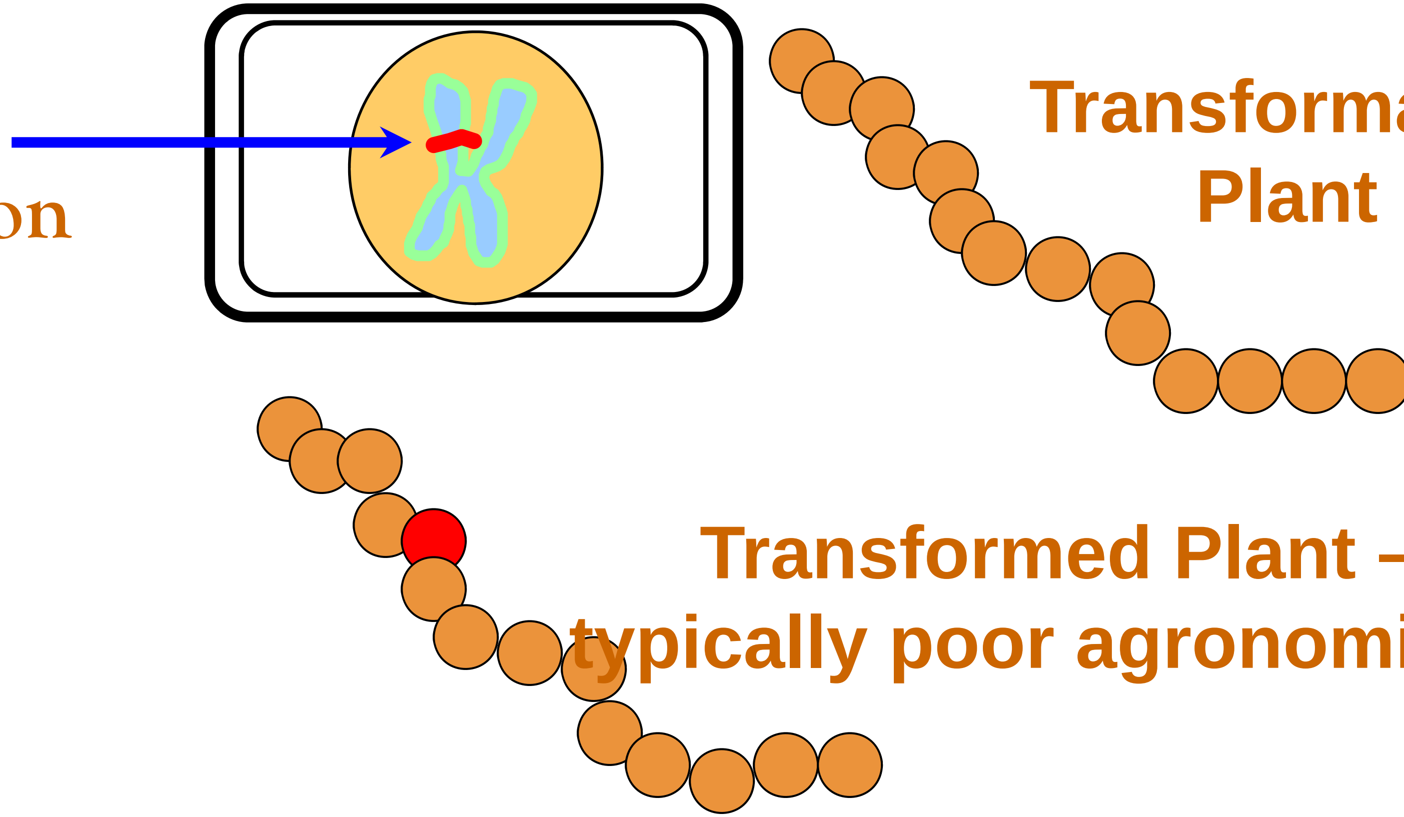
Backcross Breeding

Single Gene Transfer :
Genetic Engineering is a form of Backcrossing



Backcross Breeding

Single Gene Transfer :
Genetic Engineering is a form of Backcrossing



Thus, backcross to commercial variety via traditional backcross breeding procedure

Backcross Breeding

- **The hybrid and the progenies in the subsequent generations are repeatedly backcrossed to one of the original parents used in the cross**
- **The objective of backcrosses method is to improve one or two specific defects of a high yielding variety**
- **Recently, tungro resistance has been transferred from *O. rufipogon* by recurrent backcrossing to IR64.**